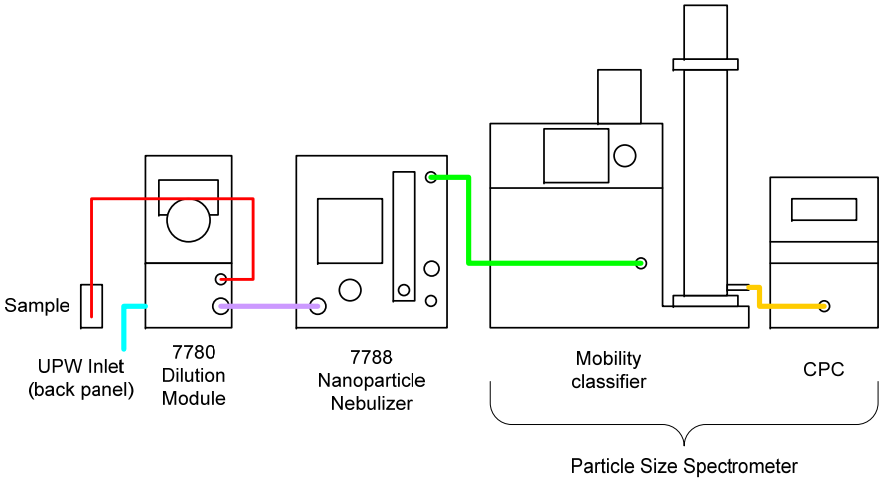
Liquitrak© Model 7780/7788/3080/308X/37XX
Liquid Nanoparticle Sizer (LNS): Quick Start Guide

System Overview

The LiquiTrak Model 7780-7788-3080-308X-37XX Liquid Nanoparticle Sizer system measures the size distribution of particles suspended in water (hydrosol). The measurement of the particle size is done ex situ with the particles dispersed in a gas (aerosol). The hydrosol is sprayed into a fine mist (nebulization) and the mist is then dried to form an aerosol (aerosolization) composed of particles that were present in the hydrosol as well as particles formed by previously dissolved Non-volatile Residue (NVR). The influence of the NVR on the true particle size and the overall distribution is mitigated by both limiting the size of the droplets (larger droplets contain more residue and therefore cause a thicker particle coating or larger residue-based aerosol particles) and optionally reducing the amount of NVR present in the nebulized sample. The amount of NVR present is limited by using online dilution which reduces the concentration of dispersants in the sample without concern for coagulation due to the short residence time between dilution and nebulization, and also reduces contamination from lab ware and the atmosphere.



The LNS consists of three main components: Model 7780 online dilution module; Model 7788 NanoParticle Nebulizer; Model 3080-308X-37XX particle size spectrometer (consisting of a mobility classifier and Condensation Particle Counter (CPC).

The figure above shows the piping configuration for an LNS operated in the online mode, where the sample flow passes from the Dilution Module to the Nanoparticle Nebulizer, and then through the classifier and on to the CPC. The Model 7780 Dilution Module mixes the sample colloid with high purity water to form a hydrosol for analysis, thus limiting the addition of non-volatile residue which can come from a manual dilution process. Online dilution also reduces the concentration of dispersants in the sample without concern for coagulation.

This Quick Start Guide is intended to be used for quick reference only.

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Warnings

- The LNS contains components that can expose you to high voltage if the instrument covers are removed. **Do not operate the equipment without the covers in place.**
- The Particle Size Spectrometer contains components which may expose you to high voltage and radiation. Refer to the Particle Size Spectrometer user manual for detailed information
- The aerosol particles created by the Model 7788 Nanoparticle Nebulizer may pose a health risk if inhaled. If not connected to other instrumentation, vent the aerosol output to a fume hood.
- The rollers on the peristaltic pump can pinch fingers. Refer to the pump user manual for detailed information.

Materials and Site Requirements

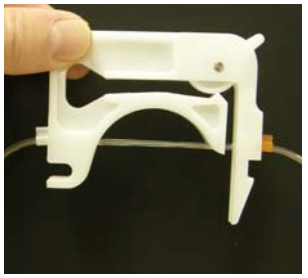
Check that you have the following tools, equipment, and site requirements before you begin. Refer to the relevant user manuals for instructions about the fluidic fittings.

- Unrestricted air flow around the system components.
- An electrical power supply with 5 outlets, 115VAC to 230VAC.
- A ¼ in (outside diameter) Teflon PFA tube, flared and fitted with a Flaretek nut, used to deliver high purity water at 20-70 psig, 50-250 ml/min.
- A ¼ -inch (outside diameter) plastic tube fitted with Swagelok nut, used to drain waste water from the nebulizer.
- A vacuum source which can connect to a ¼ OD port fitting at 1 SLPM, < 350 mmHg (Model 7780-7788-3080-308X-3772 only).
- An adjustable wrench.
- A clean tube cutter.
- Drain for receiving waste water.
- Stopwatch and 100 ml graduated cylinder.
- Scale with 0.1 mg resolution.

Note: No tubing is supplied to connect the LNS to air or water supplies.

Installation

1. Connect the UPW inlet on the Model 7780 Dilution Module to the UPW supply.
2. Install the peristaltic pump tubing on the Model 7780 Dilution Module as shown in the following figures. Place the open end of the tubing into a waste container.



3. Connect the outlet of the Model 7780 dilution module to the Model 7788 Online Sample Inlet using the included union fitting P/N ###.

4. Connect the gas supply to the rear of the Model 7788.
5. Connect the drain line to the rear of the Model 7788 and place in an appropriate waste container.
6. Using the provided conductive tubing, connect the aerosol output from the Model 7788 to the inlet of the Model 3080-308X Mobility Classifier. Use the shortest practical length of tubing to minimize particle losses through diffusion.

   Note: Refer to the Particle Size Spectrometer user manual for detailed installation and configuration instructions.

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Operation

Setup

1. Turn the Sample Selector Valve to ONLINE and check that the DIRECT Injection Inlet plug is in place.
2. Turn on the power for all pieces of equipment.
3. Turn on the gas supply.
4. Turn on the UPW supply. Water drains from the open tube end. Adjust the tube tensioner to 2 clicks past the point where water ceases to drain from the tube.

5. To ensure that the pump is operating, check that air bubbles are present in the Nanoparticle Nebulizer waste line.
6. Inspect the system for leaks.
7. Press the RESET button on the Dilution Module pump until the dash marks on the display move toward the open tube end (indicating the direction the pump is flowing).

8. Press the RUN STOP button. Use ▲▼ to adjust the flow to 100 µl/min.
9. Adjust the flowmeter valve on the Nanoparticle Nebulizer to read 100 ml/min at the center of the ball.
10. Select F1 on the Nanoparticle Nebulizer display screen. On the resulting Device Status screen, adjust the UPW pressure knob to read 18 psi. Note Iterative adjustments may be required to avoid changing the flow.
11. On the back panel of the Nanoparticle Nebulizer, adjust the gas pressure to reach 35 psi.

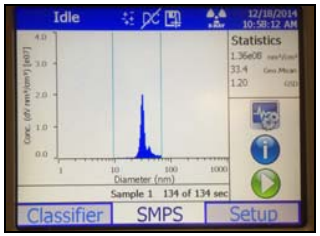
Particle Size Spectrometer Setup

Refer to the Quick start guide provided with the Particle Size Spectrometer for instructions on the device assembly and configuration. Note the following.

- The aerosol flow rate drawn from the Nanoparticle Nebulizer must be at least 1 L/min. Lower flow rates may cause condensation in the lines. If using the TSI Model 3772 CPC, the nominal flow rate is satisfactory. When using the TSI Models 3775, 3776, 3787, or 3788; the CPC flow rate must be set to 'high flow mode' (1.5 L/min).
- The sheath flow on the Mobility Classifier determines the dynamic range of the device as well as the resolution. Higher sheath flows provide finer resolution (the resolution is proportional to the ratio of the sheath to sample flow rates) with an upper limit of about 10 for the 3081 DMA and 20 for the 3085 DMA. Higher sheath flows also limit the upper measurement range of the system. Typical operating conditions use sheath:sample ratios of 10 (e.g. 15 L/min for a CPC flow rate of 1.5 L/min).
- The size measurement range for the 3081 Long DMA is 10-1000 nm, and for the 3085 nano-DMA is 2-150 nm.

Operating the Particle Size Spectrometer

1. On the TSI Model 3082 Mobility Classifier display screen, select the SMPS tab > Properties icon > FLOW tab > set the Sheath flow to 15 L/min. Select the SCAN tab to set the sample rate and size range.



2. If you are using an X-ray neutralizer (such as a TSI Model 3088), check that the source is turned on.
3. Verify that the CPC display is reading approximately 0 Particles/cm^3.
4. Select Play on the SMPS display screen to begin a scan.

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Sample Introduction

The sample is introduced to the Dilution Module using a peristaltic pump. Detailed instructions for operating the pump are included in the pump user manual. Set the diluent flow rate using the flowmeter on the front of the Nanoparticle Nebulizer; the operating range is 50 – 250 ml/min. Typical operating conditions are 100 l/min for the sample flow and 100 ml/min for the diluent flow. (See Nanoparticle Nebulizer User Manual for detailed instructions.)

1. Rinse the outside of the peristaltic pump tubing using UPW and the included bottle.

2. Press the RESET button to reverse the pump to begin injecting the sample into the Dilution Module.
3. Flick the outside of the tubing to remove residual water droplets.
4. Insert tubing in vial. Wait for at least 10 minutes for the mixed sample concentration to reach the steady state.
5. At the end of the measurement, remove the tubing from the sample, place into a waste container, and reverse the pump feed by selecting the RESET button.

Calibration

To perform quantitative analyses, the dilution ratio and inspection volume must be known. These values are calibrated at the factory but should be verified periodically. To perform a flow calibration:

1. Calibrate the rotameter by measuring the dispensed volume from the waste line from the Model 7788 using a graduated cylinder and stopwatch. Use the measured flowrate in calculating concentration and inspection volume
2. Calibrate the peristaltic pump.
   a. Weigh a plastic 60 mL bottle (not provided) and record the weight to 1/100 gram (0.0001 g).
   b. Press **RUN/STOP** to turn on the pump. Start a stopwatch at the same time. Run the pump for approximately 10 mins. Press **RUN/STOP** to stop the pump. Stop the stopwatch at the same time. Record the duration of pump operation.
   c. Weigh the 60 mL bottle and then calculate the flow rate (f):

$$f = \frac{weight(mg)}{time(\min)}$$

   d. To permanently enter a flow rate correction into the peristaltic pump, press the **CAL/MAX** button. The Display flashes. Using the **Settings ▲▼** arrows, adjust the display to match the calculated flowrate. Press the **CAL/MAX** button again to enter the new calibration value.

Calibrate Inspected Volume

1. In the AIM software, set the measurement range to 9.85 - 68 nm.
2. Perform a scan of the FMT 1004 Volume standard.
3. Verify the Volume weighted GSD < 1.22.
4. Enter the volume concentration nm^3/cm^3 sample rate, and total UPW flow into the worksheet (provided on the LNS USB drive).
5. Enter the nominal detector flowrate on the worksheet.
6. Enter the calculated inspection volume given on the Nanoparticle Nebulizer Calibration screen. (See Nanoparticle Nebulizer User Manual for detailed instructions.) The range should be 0.2-1.0 µl/min. If the volume is outside this range, contact FMT for assistance.

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